II

Getting a Genome

HUMAN EVOLUTION is a long, tangled tale that ties us inextricably to everything on this earth and, plausibly, to everything in the universe. In this day of Darwinian sensibility it is no more necessary to defend biological evolution than it is to defend the roundness of the earth. It seems evident that our genome—the sum of an individual's genetic material that constitutes the forty-six chromosomes in humans and controls heredity—is a product of millions of years of evolution.

We began as the species *Homo sapiens* in the Pleistocene about 500,000 years ago, but our genome is as old as life itself. Imagine the human genome, composed of chromosomes passed on to us, one-half from our mother and one-half from our father, as a precious heirloom made up of jewellike strings of genes, composed of DNA, nucleic acid combinations, that determine the way we look and function biologically and predetermine to some extent our potential. Because of the vast possibilities for our parents' chromosomes to divide and recombine, each of us, except for identical twins, is born with a different genome. The source of this genetic material has been passed on to us not only through our parents and generations of humans, but from archaic ancestors: primate, mammalian, reptilian, amphibian, ichthyian, and down to bacterial forebears of life on earth. The specific human part may be imagined as composed of diamondlike genes nestled in clusters of primate pearls, which in turn are 19 distributed among a massive, gemlike heritage of still older ancestral markers. Recent genetic research showing commonalties of our genes with other species substantiates our innermost feelings that we all came from the same source.

We are not, however, what we always were. Genetic change does occur and can be extremely rapid in small, intensely selected populations—as in the remnants of a decimated group, with some island populations, or among domesticated plants and animals. But the evidence of genetic change in hominid paleontology is consistent with the slow rates of change occurring in wild populations, probably on the order of a few gene changes per 100,000 years. As a result, our Pleistocene specieshood owes little or nothing to evolution during the last 10,000 years, except perhaps for some local shifts in gene frequencies associated with resistance to epidemic disease, food allergies, or crowding, along with a widened diffusion of genes among races that were isolated earlier on.

The sweep and surge of modern evolutionary studies and the sallies and feints among anthropologists debating our human ancestry are to an onlooker like the crisscrossing tracks of a herd of restless wildebeests. Our archaic genealogy seems to have begun with the prosimians and their preoccupation with group life that is central to human identity. They were followed by the Old World arboreal simians, monkeys who divested themselves of ancestral prosimian dependence on the sense of smell but who elevated the social nexus to new levels.

When the primates came down from the trees, becoming in part or wholly terrestrial, as some 150 species have done, things happened in an interlocking fashion. Fossil bits and pieces begin to show a family of eighty-pound hominids, various species of what are now called *Australopithecus*. The big toe came in line with the other toes as the pelvis and legs made more dramatic changes than the shoulder girdle. There was a shift from quadrupedal to bipedal locomotion, more specialized use of feet and hands, and an increase in body size and accommodations in body shape to the upright position. Early bipedality emerged in complicity with the bones of our pelvis and feet. Sexual dimorphism, the differences between males and females, appeared. Social organization tightened up. Analysis of dentition reveals that what our ancestors ate is probably still best for us to eat and illuminates the reciprocity of tools and teeth and jaws, tongue, and pharynx that made possible the emergence of speech.

These major human modifications and adaptations are probably related to the emergence of human bipedality. As C. L. Rawlins puts it, "I'm a primate evolved for foraging the African savannah. My basics—legs, eyes, hands—are suited to light scavenging. My eyes are good at picking up quick movement, the flop of vultures from a lion kill or the scuttle of rabbits into brush. My hands are good for wrenching the joints of carcasses, prizing roots from the earth, plucking leaves and berries. Like my hands, my digestion is able to handle a wide variety of things."[1]

Robert J. Blumenschine and John A. Cavallo have suggested that among our early hominid ancestors, "scavenging may have been more common than hunting two million years ago at the boundary between the Pliocene and Pleistocene epochs."[2] Because of our tendency to "project current ways of life into the past," many anthropologists have failed to see the advantages of scavenging in our archaic past. But in terms of energy expended as compared with caloric intake, scavenging of dead animals makes sense. Mixed groups or individuals of these first hominids were probably expert at exploiting the immediate environment by scavenging dead carcasses, gathering all sorts of vegetation, insects, and larvae, and snaring or catching small game and fish. It follows that this sort of foraging activity would precede individual and group hunting of large mammals until strategies and know-how made it

possible to procure large game without expending great quantities of energy.

A heritage of climbing ability may likewise have preadapted these hominids to stealing antelope kills stashed in trees by leopards or watching lions and jackals in the hunt while perched safely aloft. Vultures, in an extensive net of soaring individuals, watch each other, so that around birds descending on a carcass a centrifugal vortex is formed that may draw others from hundreds of miles away. A smart terrestrial scavenger and good runner, watching the vultures from the ground, might cover several miles in time to benefit. Night restlessness, typical of terrestrial primates, may be a precaution against dangerous predators. It may also have been a way in early primates of recognizing the sounds of panicking prey or roaring carnivores at night—in order to remember the direction of kills that could be scavenged. This implies the perfection of mental maps and the ability to picture the known terrain. Finally, foraging in groups and carrying sharp tools may have furthered the transition from scavenging to large-animal hunting.[3]

As Blumenschine and Cavallo point out, foraging societies are egalitarian and one can envision the free overlapping and reversal of roles of female and male hunter/gatherers depending on circumstances. What group hunting brought was the development of sharing and cooperation and increased capacity to communicate among each other and to read the body language and other signals among dangerous carnivore competitors.

A division of labor appears to have developed very early in our ancestry—it exists in most foraging cultures today—and must have advantaged survival. Children of both sexes would have had a basic grounding in scavenging strategies and an understanding of the distribution and appearance of plants and animals with the seasons. Likewise, they would have developed skills in locating carcasses before competitors, such as hyenas and vultures, or observing them and driving them off.

Standing upright opened the way for a more dexterous use of forearms, so these archaic forebears could not only stand up like chimps and bears, but could also run and carry things. If it was not for carrying babies in their arms, why would this capability emerge when a chimplike prototype did so little carrying? The human lack of hair to which babies (like little chimpanzees) might cling made that mode impossible, as did the added disadvantage of the jolts created by running upright.[4] Was uprightness also for carrying spears, escaping/pursuing in open country, seeing over tall grass, picking the seeds from high grass? The need to carry things to a central camp by these socially cohering food-sharers may have prompted woven bags long before any records indicate. Moreover, sunglare is an important limitation in bright, open-country savannas where humans first emerged.

One wonders whether the heavy-browed ape skull was not preadapted to giving eyeshade to our ancestors who by that time had their hands full. We come from a long line of primate omnivores. Just exactly when our teeth took distinctive shape and how this was related to scavenging and predation, the emergence of speech, and use of tools is part of the intellectual mix of modern anthropology. In our past history, primates and ourselves had some common ancestry, and we share much with those present on earth with us today. Among contemporary nonhuman primates, one or another species hunts, shares, cooperates, carries, keeps kinship ties, divides labor sexually, prohibits incest, makes tools (in both gathering and hunting contexts), shows linguistic capability, or has a long memory. All together these are the greatest story ever told.[5]

We also share habits of eating that include consuming "flesh" in various forms. Anthropologist Robert Harding has shown that 69 percent of all primate species deliberately eat invertebrate or vertebrate foods. "Primates," he says, "can only be described as omnivorous; they are definitely not vegetarian animals." [6] Shirley C. Strum, in her studies of baboons, has observed them cooperating to hunt other mammals, sharing the kill, and carrying the kill to eating sites.[7] As recorded by anthropologist Geza Teleki, chimpanzees while hunting utilize "cooperative production," all spacial dimensions of their habitat, food sharing, and division of labor.[8] Hot food, the "warm meal" of which the raw, freshly killed animal is the prototype, is the sine qua non of the palate. The main difference between human hunters and today's nonhuman primate predators is that the latter do not hunt prey larger than themselves.

WE CAN TRACE OUR PROSIMIAN ORIGINS, anthropoid kinship, the shared skeletal, dental, and neurological features of our family, the Pliocene hominids, from which our own branch made its departure more than five million years ago. About two million years ago our ancestors emerged from their Australopithecene preamble as the genus *Homo*, bipedal, with a chimpanzee-sized brain, poised on the brink of an ecological adventure unknown to the other primates.[9] Out of that past emerged the great variations and races found in humans on earth today.

A useful way to think of this sequence of events is not in terms of taxonomy but of significant shifts in mobility and diet. Many who write on human evolution emphasize rapid changes rather than the slow evolutionary grind implied by "mutations." The mutated forms of genes do not usually swing into instant action to produce physical realization or "phenotypes," forms with visibly different characteristics.

They remain in the gene pool sometimes for thousands of years, being eliminated on a regular basis, unless they find the right environmental circumstances—at which point they become visibly expressed in the creature's physical characteristics or behavior.

The biology of a basic human genome does not contradict variation. Nor does it imply that one race is better than another except in the context of specific environmental challenges. Psychological differences may occur between populations and races, since cognitive abilities are related to specific tasks and may vary due to selective pressure in different environments. The key to the diversity of human behavior may yet have its origin in the primate past—in a peculiar bimodality of the genes that may open us to possessive, competitive, cultural expression or to the more cooperative sharing cultures typical of Pleistocene peoples.

Both aggression and cooperation may be intrinsic and available to various human economies. In his book *Social Fabrics of the Mind*, primatologist Michael R. A. Chance suggests that two basic tracks were open to different primates in their social relations. Human evolution, being heir to a wide range of different species of ancestral primates, bears vestiges of both realms, making the human personality subject to alternative possibilities.

These two "mental modes," combining brain structure and social relations, he calls the Agonic and the Hedonic.[10]

The Agonic personality is typified by the rhesus monkey. Its attention constantly flows toward the higher rank, making it "centrist" in its orientation. Unprovoked aggression, threat, and reconciliation give society its pulse. Low rankers get back into the group by "reverted escape" and submission.

High tension characterizes the group. Sex becomes symbolic of power. The Hedonic personality is more like that of the chimpanzee with its appeasement, reassurance, and mutual dependence. The normal arousal level is low, there is little aggression. Threat is subject to reconciliation and reunion. The group has a strong general sense of unity, even though it may appear in disarray to an outsider. This bimodality, says Chance, is "deep-seated in our nature." Its outcome depends on the social system that cues us and to which we apply its logic. If our "way of life" is efficaciously described in terms of its diverse relationships, then it can meld these two opposing personal and social modes in gradations, even distinctive ratios. Hunting/gathering, says Chance, is based on an equality principle expressed in fluid, reciprocal, social relationships and role integration that values teamwork. But its egalitarian style can regress into a rank-dependent, self-defensive arousal focused on self-security if it is unduly stressed, just as it does in chimpanzees.

The world of both chimpanzees and human foragers is typically safe and sufficient. Groups are open and followership is voluntary without fixed leadership, small groups dissolving and reforming differently. Individuals are normally calm and charismatic. All returns are immediate—as distinct from delayed return systems with storage in which cultivation of the soil and rights over assets such as boats, traps, and structures are protracted.

The Hedonic system of mutual dependence, confidence, trust, and good-natured mutual assurance is not, says Chance, just a social creation of humans but a basic biological mode among certain primate kin, just as the competitive, aggressive mode is also in our genes from yet other relatives.

THE MOST EXTRAORDINARY FEATURE of human evolution is ontogeny—the specialized and scheduled development of physical and psychological traits that appear, disappear, or stagnate during the life cycle of the individual. *Onto-geny* literally means "the genesis of being." Of all the biological characteristics of humans originating over the millions of years of our later primate ancestry, and disastrously ignored in our perception of ourselves, ontogeny sets the timetable of the whole individual life.

Mice and other nonhuman animals, whose life cycles were first studied by biologists, do not change conspicuously after sexual maturity, nor do they live long. Most species of animals produce large numbers of young that develop rapidly and, typically, die before becoming adult or have just a brief existence as an adult. As a result of the early studies on animals, ontogeny is usually narrowly defined merely as the period from birth to physical maturity. But this is a misconception in terms of human development.

Psychological changes continue in humans long after we have matured physically. Some species, including our own, give more time and energy to these sequences of biological imperatives—for example, we humans devote a great deal of care to slowly developing our young whereas rodents invest in numerous progeny and thus accommodate high mortality rates.

Human life stages cover seventy or so years, during which span traditional societies recognize a rich sequence of passages and roles. Human longevity is often misunderstood simply as more time to play, to grow, to learn, as though we had an add-on gift for getting more time out of life. Social support during these life stages is the yeast of maturity, the mentality of growing up.[11] Perhaps much of the violence, identity crises, and family disruptions in our time begin because we do not attend to the genetic "expectation" of such changes in our lives as the individual faces

developmental challenges.

In childhood there are three neurobiological stages of mental representation: enactive, iconic, and symbolic. The first stage, the enactive, is basically mammalian and is largely sensory—body movements that trace first their mother or caregiver's body, its smell and feel, and then the larger environment around them, the movement through space, and the imprinting of place and its components (weather, water, rocks, soil, plants, animals, people). In this beginning stage, children explore their way through their environment much as rats in a maze or animals in their natural habitat. Touch, smell, and hearing are especially important in this most fundamental orientation. Iconic representation takes place in a series of signs and images of increasing complexity. The figures of humans drawn first by young children —arms and legs with fingers attached to a head—that progress as the children grow older to more realistic representations of the human body illustrate the progressive development of this sign world. Speech is part of this mode of understanding because the icon represents some part of the environment. The child early on knows what a "bow wow" represents and does not confuse it with a "moo cow." And later the child can distinguish between dogs (and people) by ascribing proper names. The third form of representation is symbolic—a way of referring in which the symbol may lose any similarity to what it stands for (an "overdetermined" metaphor) and its "meaning," therefore, must be learned and taught. These three stages of representation follow a hereditary ontogenetic agenda.

Psychologically we are ontogenetic as well: the personality and temperament follow characteristic patterns and needs laid down over the Pleistocene. While conventional psychology and child development recognize this ontogenetic imperative, they have seldom asked where it comes from, why it is there, or how it was adaptive in our evolution.

More is known in child care about the failure of the enactive phase because it is so much a part of mother/infant relations and the psychopathologies that follow its failure. The absence of a functional iconic basis in nature impairs our sense of the diversity of life or the implications of terrain, earth, and its life. Ontogeny does not imply that we redress our errors by feeling good about nature instead of fearing or wanting to control it. As a highly specialized life form, we are genetically endowed to "expect" fulfillment of the genome's childhood schedule of needs and abilities, to which society is tutor and guide with its tests, informal daily life, and formal ceremonies that erupt and fall in time like the successive molts of feathers on the body of a bird. Our extended human ontogeny, with its natural demarcations in stages and phases, is governed by neoteny (a "state of newness")—a retardation of certain parts of the maturing process. Neoteny preprograms life stages, so that our becoming is a lifelong process.

We, among all creatures, are in some ways the most free. Yet, even though blessed with wider choices than the other animals, we are not truly free to be immature, or for culture to neglect to mitigate our immaturity.

That modern psychology has taken the wrong track is reflected in the popular narcissism of the self and the study of the personality as though adolescent self-absorption were normal in the context of the hubris and hedonism of our affluent society. Modern psychology, including "eco-psychology" and "environmental psychology," tends to portray the self in terms of individual choices about beliefs, possessions, and affiliations rather than defining the self in terms of harmonious relations to others—including other species—and in terms of the ecological health of the planet.

Ontogeny includes a synchrony of brain and neuromuscular development that corresponds to the wants and needs of the individual. Culture—a heritage of skills, attitudes, traditions, language, and arts—evolved out of a biological potential embedded in this ontogenetic agenda.

Cultural responses to our inherent development as individuals have content. They have been worked and reworked so long that there is empirical wisdom in the social and cultural mentoring of the individual. The "extended childhood" and the characteristics of the adult that carry youthful traits into later life are therefore at the heart of human biology and evolution. The agenda is a given; the support depends on a social readiness to nurture, itself a product of successful ontogeny of an older generation. To the often asked question, "Why don't you grow up?" perhaps the answer should be, "Because I need a bit more time and understanding."

I PROPOSE that our ontogenetic agenda has been carried in our genome from Pleistocene times when our species made its debut. Furthermore we have inherited from our primal ancestors an orientation to the world, a way of perceiving our place in the scheme of things. Let us go back for a moment to a long view in order to retrace those first steps toward our present humanity.

About two million years ago, at the border of the Pliocene and Pleistocene epochs, our first ancestors, *Homo habilis*, moved out toward the forest edge. Following corridors of riparian woodlands, where, being partially arboreal, they could in time of danger seek the sanctuary of trees, they could also make excursions into open country. In such a habitat they would have access to grass seeds, ground-nesting birds, certain reptiles, young mammals, and carcasses from big cat kills. Eating grass seeds may have stimulated the upright stance—freeing the hands—which would have

helped not only gathering but general lookout in tall grass. The number of large, dead bodies available to these human scavengers would have increased in the savanna ecosystem not only because of the larger number of animals and their predators but also due to natural death in the dry seasons. Big dead bodies, moreover, last longer than small ones. Meat is a welcome food among higher anthropoids, and the opportunities may have sharpened their attention to the behavior of carnivores and strategies for finding and using flesh of carcasses. Windfalls of meat from large animals were advantageous mainly if some of it could be carriedaway—served not only by bipedality but also by ahead-thinking and sharing.

The oldest known tools coincided with the earliest members of the genus *Homo* when they probably began to cooperate in foraging and food sharing as they scavenged in the riparian woodlands or open areas. These were percussion pieces for the extrication of roots from the earth and meats from nuts and for smashing bones. Early on, before cutting tools, human scavenging would have depended on the dead whose body cavities had already been opened or whose meat had been stripped. Percussion stones were used for breaking the larger bones to get the marrow and for opening the cranium to extract the brains. The sharp edges of fractured bones may have served for cutting, preceding the use of shaped stone for defleshing dead bodies. Competition with other scavengers and the ability to drive carnivores from their kills would have also facilitated the evolution of weapons. There was, however, not a single tool of the Pleistocene apparently made for war.[12]

To cut more precise pieces, sharp flint edges, choppers, axes, and stone flakes appeared. Humans began looking inside animals, opening bodies, noticing that parts of different animals corresponded, the parts themselves becoming "species" with their own taxonomy. We made the marvelous discovery that inside we and the others were even more obviously kin than indicated by our exteriors. But in scavenging dead bodies, we never abandoned a general subsistence that kept our omnivore bodies healthy and turned our attention to the whole landscape. Gathering and scavenging, as noted earlier, are not distinct activities separated from hunting, nor do they require less acumen. Scavenging large animals requires many of the same skills needed in hunting.

Prehuman foragers, even in their earliest centuries at the edge of the forest, were never so stupid as to simply ramble about, blindly following chance probabilities of encounter, rather than exerting the kind of superior intention that is obvious in all primates. Avoiding and outsmarting predators, sensing where fruits are ripening and roots are plentiful, distinguishing poisonous herbs and fungi, recognizing plants with healing properties, being wary of signs of kills for possible scavenging, thinking ahead in terms of the need for tools for digging or breaking open bones— all this necessitated planning and fore-thinking. Developing a keen awareness of the environment and its potential for food sources, as well as the conceptualization of mental maps required higher mental skills than just reading signs. It also required passing some of the information on to progeny.

Hunters frequently stop to pick and pluck—to "gather"—eggs, turtles, frogs, and insects that may be eaten on the spot; a gathering group not only digs roots and picks berries but also kills small game and scavenges. While the origins of the intelligent human hunter/gatherer go far back into the social structures of ancestral lemuroids and the vocality and vision of arboreal simians, the breakout comes with savanna omnivory: now intelligence was fostered among bipedal scavengers carrying tools with cutting edges and finally cooperating to kill large game and share food. Some crucial social and intellectual mileposts had to be passed in order for our ancestors to hunt cooperatively and share large animals. Our hunting began two million years ago with the 500-cubic-centimeter brain that reached 1,500 cubic centimeters about fifty thousand years ago—and with this increase in brain size came a concomitant ability to conceptualize. Very early in the story, for example, the recognition of other species at a distance would have simply extended a preexisting ability of all large vertebrates in the circumstances of savanna life. Soon after would come a quickness for attaching sounds or smells to those same species, even when they were not visible. And, like wolves, the human predators would have expanded these recognitions to subgroups within the species in order to know which antelopes or zebras were old, sick, pregnant, and very young and which would defend themselves dangerously or flee with ease. The success of carnivores—including the human as carnivore—is always marginal.

Playing the odds is essential. As our hominid ancestors increasingly moved into open country, often in sight of prey for hours at a time, it was possible to recognize a kind of daily round of other species, if one had the memory for it, to know when the prey slept, grazed, watered, or changed locations for special feeding, courtship, or bearing young. With forethought the hunter could be present in those places before the prey or ambush them along the way. Ambushing suggests the use of cover, and it is not difficult to guess that our forebears watched lions and cheetahs using not only the vegetative cover but rock and terrain to stalk, and learned to imitate them. At some point the idea of such observational learning must itself have become conscious, so that every species of animal became a potential teacher. Nor would it have been only the predators who were seen as models: the cunning of prey must also have been the object of our ancestors' inquiry and admiration. At a weight of 70 pounds millions of years ago

or 150 pounds thousands of years ago, they would have continued to be the object of the hunt themselves. Species of canids, cats, and hyenas now extinct as well as those with us today probably relished all kinds of primate flesh.

We would not have endured as smart hunters if we were dumb quarry. The canids and lions would surely have been models of cooperation in the hunt as well as in the division of labor. The aptitude for working together and not spoiling it at the end in conflict would have been, then, more than a mere discovery. It would have required new social skills and understanding. Individual personality would surely have been a large part of this awareness. Having learned from the animals and the nonliving surround, our primal forebears emerged from the Pleistocene wary, able to discern advantage in chance encounters as well as skilled in planning ahead, keenly sensitive to the environment and its signs, communicative, cooperative, and sharing.

THE KIND OF INTELLIGENCE and cunning needed by our primal ancestors to develop and survive as they did during the Pleistocene has been overlooked. Or, worse, it has often been translated into a condescending attitude toward modern aboriginal people who are seen as "savages." The cruelest form of modern criticism of primal peoples depicts them as stingy and greedy as anybody else, implying that to be human is to be selfish.

The most strident of these theories projects overkill onto the aboriginal inhabitants of the world by claiming that, being basically avid, they were responsible for the extinction of many large animals at the end of the Pleistocene. Invading hunters from Asia, the argument runs, exterminated the giant sloths, mammoths, and horses. Their relentless pursuit of hapless and trusting animals who had never seen humans presents a portrait of grisly slaughter indeed. We are encouraged to picture cliffs where men drove bison or horses to their deaths—a kind of epigram for the whole sordid episode of the hunters' blood lust.

Studies of hunting/gathering peoples show that to hunt big mammals exclusively is bad strategy: generalized subsistence is more efficient and reliable; and indiscriminate hunting is inefficient and goes against longterm survival. Indeed, the proposed high predation of megafauna, such as elephants, among prehistoric peoples is extremely naive if one considers the time and labor necessary for hunting large animals. Archaeologist Raymond E. Chaplin says, "Prehistoric man is unlikely to have created any strong imbalance or brought many species near extinction."[13] Except in the Arctic—where the animal fats are polyunsaturated and sea ice and sea strand hunting is efficient—exclusive big-game hunting is unwise and inefficient. Most of the documented extinctions brought about by primitive humans are associated with islands or with agriculture. Donald Grayson explains that during the last few thousand years of the North American Pleistocene, as many as thirty-two genera of mammals and ten genera of birds became extinct. He argues that this episode of extinction is too narrow and the variation of extinctions too wide (ranging from blackbirds to mammoths) "to be accounted for by . . . human predation."[14] For these reasons the Mosimann-Martin model that presents the hypothesis of prehistoric overkill by humans is not convincing.

Of the known Pleistocene extinctions only 9 percent of the thirty-two extinct genera occurred during the late Pleistocene with the human advance into North America. Some 50 percent of the extinctions took place during the Gunz glaciation and 25 percent during the Riss-Wurm glaciation. Just prior to the human arrival in North America, about twelve species of megafauna vanished. Among them were a huge carnivorous bear, a gigantic lion, two genera of saber-toothed tigers, the jaguar, a cheetah, and the dire wolf. There is virtually no evidence, such as stone implements, of confrontation between humans and most of the extinct animals.

Peoples entered North America from Siberia along with the grizzly bear, moose, caribou, wolverine, wapiti, and bison, all of which survived. Their Siberian hunter descendants are known, like most such peoples, to limit their kill to the little they can store and carry. Coming from Asia, the migrants had behind them a long coexistence with the megafauna of Siberia. Conservation, not overhunting, was practiced among aboriginals—if not for ethical reasons then surely for practical purposes. In terms of caloric intake as well as energy conservation, it was advantageous to hunt species that were plentiful and to utilize multiple sources of food.[15]

Overkilling was regarded with repugnance because it led to competition and territoriality between tribes and for these reasons was virtually unknown among hunter/gatherers.[16] Little evidence exists, then, that humans were responsible for the extinction that took place at the end of the Pleistocene. In northern Asia the extinction of the mastodon and mammoth was associated with the diminished tundra; there is virtually no evidence of associations with bone accumulations. Valerius Geist proposes that humans are unlikely to have killed off the "densely-packed fauna of specialists" that became extinct on the North American continent. In fact, he suggests that the presence of these animals may have delayed human migration: two species of the sabre-toothed tiger, a huge lion, the dire wolf, and two species of the big *Arctodus* bear may have deflected the human passage down the west coast of North

America.[17] Human overkill envisions a "front" of advancing human invaders, but no such pattern of migration existed; the first human inhabitants followed vegetational and geological corridors and coasts in streamlike, not wavelike, movements. In Eurasia major game animals such as the reindeer, red deer, auroch, and horse did not become extinct at that time, while less desirable game, such as the cave bear, rhino, and mammoth, did.
Perhaps the idea that our hunter ancestors extinguished many animals appeals to our Judeo-Christian apocalyptic imagery and our chronic modernguilt from having ravished a continent. It attracts a misplaced sentiment for preserving and protecting individual wild animals. Perhaps, above all, it resurrects old fictions about primal, "barbarian" peoples as rabid animals.

THE ELEGANT REFINEMENTS of our species, as inherited in our DNA, are difficult to see because the genome is an unseen actor behind our daily behavior. Like a soft-spoken elder, its unique role is to call upon human society and imagination to invent its exact expressions. Each human group responds differently to the needs of the life cycle, the modes of foraging, the nature of the divinities, and the play of tropes and art. Human societies vary greatly in their structure, but the differences, however crucial they seem to us, are variations on the species theme— whose *human* traits are Paleolithic. The health of a society is a measure of its freedom from stress, individual suffering, psychopathology, tyranny, and ecological dysfunction as a result of straying from that basic ancestral form. The greater the degree to which a person or society conforms to our Paleolithic progenitors and their environmental context the healthier she, he, they, and it will be.

Notes

1. C. L. Rawlins, *Sky's Witness* (New York: Holt, 1993), p. 236.
2. Robert J. Blumenschine and John A. Cavallo, "Scavenging and Human Evolution," *Scientific American*, October 1992, pp. 90–91.
3. Ibid., p. 96.
4. The question of reduced hair in our species continues to be argued. The idea that it was for controlling body temperature does not square with the many hairy mammals who do not necessarily overheat. I find the logic that its purpose was erotic, part of the bonding system between male and female, to be more convincing. 5. Five thousand references are given in the library's section on evolution and anthropology. See, for example, Charles R. Peters, "Toward an Ecological Model of African Plio-Pleistocene Hominid Adaptations," *American Anthropologist* 81(2) (1979): 261–278, or John Gowdy, "The Bioethics of Hunting and Gathering Societies," *Review of Social Economy* 50(2) (Summer 1992): 130.
6. Robert S. O. Harding, "An Order of Omnivores: Nonhuman Primate Diets in the Wild," in Robert S. Harding and Geza Teleki, eds., *Omnivorous Primates* (New York: Columbia University Press, 1981), pp. 199–200.
7. Shirley C. Strum, "Processes and Products of Change: Baboon Predatory Behavior at Gigil, Kenya," in Harding and Teleki, eds., *Omnivorous Primates*, p. 263.
8. Geza Teleki, "The Omnivorous Diet and Eclectic Feeding Habits of Chimpanzees in Gambe National Park, Tanzania," in Harding and Teleki, eds., *Omnivorous Primates*, p. 340. 9. Peters, "Toward an Ecological Model," p. 261. 10. Michael R. A. Chance, "Introduction," in Michael R. A. Chance, ed., *Social Fabrics of the Mind* (London: Erlbaum, 1985), pp. 3–9. 11. Erik H. Erikson, *The Life Cycle Completed* (New York: Norton, 1985), p. 31.
12. Julia Rutkowska, "Does the Phylogeny of Conceptual Development Increase Our Understanding of Concepts or of Development?" in George Butterworth et al., eds., *Evolution and the Development of Psychology* (New York: St. Martin's Press, 1985), pp. 115–129. 13. Raymond E. Chaplin, "The Use of Non-Morphological Criteria in the Study of Animal Domestication from Bones Found on Archaeological Sites," in Peter J. Ucko and G. W. Dimbleby, eds., *The Domestication and Exploitation of Plants and Animals* (Chicago: Aldine, 1969), p. 239.
14. Donald Grayson, "Pleistocene Avifauna and the Overkill Hypothesis," *Science*, 18 February 1977, p. 692. See also Karl W. Butzer, *Environment and Archaeology,* 2nd ed. (Chicago: Aldine-Atherton, 1971).
15. Michael A. Jochim, *Hunter Gatherer Subsistence and Settlement: A Predictive Model* (New York: Academic Press, 1976), pp. 16–17.
16. Renez R. Gadacz, "Montagnais Hunting Dynamics in Historicoecological Perspective," *Anthropologica* 17(2) (1975):149–168.
17. Valerius Geist, "Did Large Predators Keep Humans Out of North America?" in Juliet Clutton-Brock, ed., The Walking Larder (London: Unwin Hyman, 1990), pp. 282–294.